

ECOLOGY OF WESTERN JUNIPER

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Western juniper (*Juniperus occidentalis* ssp. *occidentalis*) has markedly increased its range in Oregon during the last 100 years. Fire control, grazing pressure, and climate have combined to bring about this spread. Although it has moved most successfully into the mountain big sagebrush communities it is not limited to this type but has also been successful in other shrub steppe systems as well as grasslands. The expansion that has taken place follows a normal population growth pattern for a plant species which has lost its primary control factor or, as viewed from the other side, has gained suitable sites for establishment and growth.

From the management standpoint it is important to know as much as possible about the biology and ecology of western juniper to develop and implement procedures for slowing down the rate of spread and reducing the rate at which existing stands thicken. Those studies reported on below represent some aspects of the biology and ecology under investigation in central Oregon.

STUDY AREA

Research on the biology and ecology of western juniper is being carried out in Crook, Deschutes and Harney Counties with emphasis in Crook County. Intensive studies have been located on Combs Flat southeast of Prineville, and on Lytle Creek east of Grizzly Mountain.

Sex Expression in Established Stands

Study sites on Combs Flat were established to monitor sex expression of western juniper in 1982. A total of 232 trees were examined in consecutive years. These trees ranged in size from 3 feet to 36 feet in height, with 135 more than 10 feet. Trees were located in three 131 x 164 foot (.49 acre) plots and each tree numbered for repeated measurement. Tree numbers per plot were 121, 56, and 55 (x 2.04 for trees /acre). Female cone abundance was monitored for 4 years and male cone abundance monitored for 3 years.

Of the 232 trees, 11 were male in the sense that they produced only male cones each year; 90 trees produced only female cones. Seventy of the trees produced both male and female cones in the same year. Sixty-one did not produce cones of either sex during the study. This latter group was made up of trees of 3 to 10 feet in height.

Consistently high yearly female cone production occurred on 7 trees and 42 trees consistently produced large numbers of male cones. In general, trees which produced large numbers of either male or female cones in the first year continued to do so each year. A large percentage of the population is capable of producing female cones (65%), however, established stands such as these appear strongly dominated by the male expression of sex which is indicative of high stress levels associated with closed stands.

Sex Expression in Invasion Stands

Western juniper invasion areas on the north edge of Combs Flat were sampled in the winter of 1986. Five .49 acre plots were sampled with all trees measured for height and canopy radius. Additionally, sex was determined and the abundance of male and female cones estimated for each tree.

Table 1. Reproductive characteristics of western juniper in the invasion phase on Combs Flat, near Prineville, Oregon

Tree Height	M	F	M/F	UK	Abundant Seed	Total
10 ft plus	% 8.6 No. 2.5	40.2 11.9	41.4 12.2	8.6 2.5	42.5 12.5	29.5
less than 10ft	% 1.6 No. 1.6	4.1 4.0	7.4 7.3	86.8 85.1	4.0 4.0	98.0
Total trees/Acre						127.5

(M = male, F = female, M/F = male and female cones, UK = unknown sex, Abundant seed = 4-5 berries or more/ square foot of crown surface, % = percent of trees/acre, No. = number of trees/acre.)

Table 1 shows that most of the trees which produce cones of one kind or another are either producing female cones or a mix of male and female cones. In contrast to established stands the dominance of female cone-producing trees is apparent. Of trees under 10 feet tall only 11.5% show potential for producing berries (F plus M/F). On a per acre basis only 4 trees less than 10 feet tall were producing significant numbers of berries.

Western juniper in the 3 to 6 foot height range on the Combs Flat area produces a berry or two on an infrequent basis, but consistent abundant berry production occurred only in trees over 6 feet high and was confined to a very small percentage of those trees in the 6-to 10-foot height range. For three locations examined in central Oregon where western juniper was invading, 11.4% of those trees less than 10 feet in height produced one or more berries and 3.5% produced abundant berries one year or more out of two.

Regrowth of trees before they begin producing and dispersing seed onto an area is important since seeds probably retain their viability for many years. The presence of trees with large numbers of berries is also an attraction for bird species which feed on them and which then contribute

to the spread of seed about the area. On the Combs Flat invasion area, removal of 16-17 trees per acre would appear to halt seed production in the area. When stands are younger, less than 10 feet in height, removal of a very few trees could potentially halt the addition of new seed into the area.

Establishment Sites

Field observations indicated that western juniper seedlings require some protection against environmental extremes to establish. Seedlings and juveniles were commonly found beneath sagebrush plants and larger juniper trees. Of practical importance is the possibility of reducing the rate of invasion and stand thickening through the control of other plant species and/or certain individual juniper trees in the existing population.

Locations of western juniper seedling establishment were recorded on 5 plots each .25 acres in size on areas being invaded and on areas fully stocked with larger trees. The base of trees less than 10 feet tall were examined for the presence of dead or dying sagebrush or other shrubs, for rock, and for bunchgrasses living or dead. Those trees present under other western juniper trees were considered to have established under their canopies.

Table 2. Establishment locations of western juniper on Combs Flat, near Prineville, Oregon, as determined from trees under 10 feet tall

		Juniper	Sage- brush	Rabbit- brush	Bunch- grass	Rock	Bare	UK	Total
Invasion Area	%	56	18	3	8	5	1	12	
	No.	58	18	3	8	5	1	12	*130
Stocked Area	%	88	4	-	<1	-	<1	7	
	No.	730	36	-	2	-	4	54	*826

(Juniper = western juniper, Sagebrush = big sagebrush, Rabbitbrush = grey rabbitbrush, Rock = rock edge, Bare = bare ground, UK = unknown, % = percent of total trees, No. = number of individuals/acre) * There were an additional 27 trees/acre of 10 or more feet in height on the invasion area and an additional 100 trees/acre of 10 or more feet in height in the stocked area.

The majority of new western juniper trees are found beneath the canopy of a small percentage of the large dominant existent junipers. These large trees are mostly heavy berry producers but not exclusively so. Juniper

reproduction is seldom seen beneath trees of less than 20 feet tall. In the absence of large junipers, as much as 80% of establishing junipers are found beneath big sagebrush (Eddleman 1987), and in this study big sagebrush is a dominant location for establishment in those areas away from the influence of juniper canopies.

In general, the importance of maintaining minimal big sagebrush densities is indicated as is the removal of trees before reaching 20 or more feet in height. It is not known whether the abundant regeneration found under some large junipers was from seed deposition from berries produced on the tree or whether seed were deposited there as the result of animal activity. However, since several of these trees are non-berry producers, animal activity, particularly that by seed-eating birds, in spreading seed is suggested.

Growth Rate

Data on height - age were collected from 234 western juniper trees found in 3 plots each .49 acres in size on fully stocked stands on Combs Flat. Twenty dominant trees which were at least 60 years old and older were cross-sectioned at 3.28 foot (1 meter) intervals to obtain height growth rates during the early phases of establishment.

Table 3. Height growth rates of western juniper on Combs Flat. Lifetime growth rates are for those trees initiated in each decade

Lifetime in/year	Decade beginning-									
	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980
	3.5	3.5	3.5	3.5*	2.4	1.6	1.2*	1.2	1.2	0.8

(* 3.5 in/year for 50 years would equal 14.6 feet. 1.2 in/year for 30 years would be 3 feet.

Lifetime growth rates were maintained for those trees established before 1930. There was a steady decline in growth rates for those trees establish from 1930 on. By 1930, populations were approximately 55 trees per acre. Growth rate decline in individuals established in later years may reflect the development of competition with other plant species, a gradual closing of the juniper stand to the point individuals are competing with each other, or changes in other unknown environmental factors. Invasion of western juniper into big sagebrush stands would not be apparent for at least 10 years since it would take approximately that long for the trees to overtop the sagebrush plants.

Height growth rates of the dominant trees were much greater than the average of the population. These trees grew at 3.5 in/year for the first decade of their life but gradually increased to 6.6 in/year at 34 years of age and maintained growth rates in excess of 5.1 in/year through the rest of there lifetime. Dominant trees had a lifetime average height growth rate of 5.3 in/year. The oldest trees aged on Combs Flat were 90 to 100 years old and these either had or were developing rounded tops indicating a general cessation of height growth.

Growth rate data for the dominant trees indicate that at least 27 years would be required to reach 10 feet in height and at least 40 years to reach 20 feet in height. These values are a probable minimum time required to reach these heights but do give rough guidelines as to the time span between establishment, the initiation of berry production, and the beginning of heavy berry crop production.

LITERATURE CITED

Eddleman, L.E. 1987. Establishment and stand development of western juniper in central Oregon. p 255-259. In: Everett, R.L. (Comp.) Proceedings Pinyon - Juniper Conference. U.S. Forest Service General Technical Report INT-215.